IMPLEMENTATION OF VARIABLE HYBRID ENERGY SYSTEM BASED ON MPPT TECHNIQUE

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ABSTRACT

This paper proposes a hybrid energy system consisting of wind, photovoltaic and fuel cell. Battery storage is designed to run the system continuously. Environmentally friendly solutions are becoming more prominent than ever as a result of concern regarding the state of our deteriorating planet. This paper presents a new system configuration of the front-end rectifier stage for a hybrid wind/photovoltaic energy system. This configuration allows the two sources to supply the load separately or simultaneously depending on the availability of the energy sources. The inherent nature of this Cuk-SEPIC fused converter, additional input filters are not necessary to filter out high frequency harmonics. Harmonic content is detrimental for the generator lifespan, heating issues, and efficiency. The fused multi input rectifier stage also allows Maximum Power Point Tracking (MPPT) to be used to extract maximum power from the wind and sun when it is available. An adaptive MPPT algorithm will be used for the wind system and a standard perturb and observe method will be used for the PV system. Operational analysis of the proposed system will be discussed in this project.

Keywords: ***Energy system, Boost converter, Solar panel, Wind system.***

I.INTRODUCTION

With increasing concern of global warming and the depletion of fossil fuel reserves, many are looking at sustainable energy solutions to preserve the earth for the future generations. Other than hydro power, wind and photovoltaic energy holds the most potential to meet our energy demands. Alone, wind energy is capable of supplying large amounts of power but its presence is highly unpredictable as it can be here one moment and gone in another. Similarly, solar energy is present throughout the day but the solar irradiation levels vary due to sun intensity and unpredictable shadows cast by clouds, birds, trees, etc. The common inherent drawback of wind and photovoltaic systems are their intermittent natures that make them unreliable. However, by combining these two intermittent sources and by incorporating maximum power point tracking (MPPT) algorithms, the system's power transfer efficiency and reliability can be improved significantly.

When a source is unavailable or insufficient in meeting the load demands, the other energy source can compensate for the difference. Several hybrid wind/PV power systems with MPPT control have been proposed and discussed in works.

Most of the systems in literature use a separate DC/DC boost converter connected in parallel in the rectifier stage. To perform the MPPT control for each the renewable energy power sources. A simpler multi input structure has been suggested by that combine the sources from the DC-end while still achieving MPPT for each renewable source. The systems in literature require passive input filters to remove the high frequency current harmonics injected into wind turbine generators. The harmonic content in the generator current decreases its lifespan and increases the power loss due to heating. In this paper, an alternative multi-input rectifier structure is proposed for hybrid wind/solar energy systems. The proposed design is a fusion of the Cuk and SEPIC converters.

II.PROPOSED HYBRID SYSTEM

The block diagram consists of wind energy system, solar energy system, fuel cell units, boost converter, inverter. The combinations of the solar system, wing system, fuel cell are known as hybrid system. Renewable energy systems generate low voltage output, and thus, high step-up dc/dc converters have been widely employed in many renewable energy applications such fuel cells, wind power generation, and photovoltaic (PV) systems.

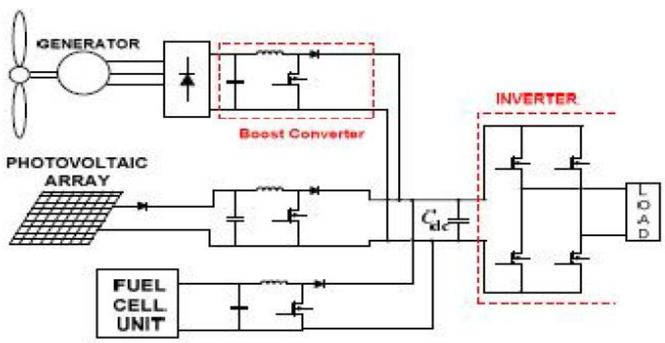

FIG.1. Proposed model of hybrid system

The output of these renewable energy sources contains some harmonics and they have to boost up or boost down due to the needs. Here boost converters are used to boost up the output of the renewable energy sources (i.e.,) convert low voltage into high voltage step-up converter and then given to the inverters. Inverter used to converter the DC into AC sources. This AC sources are given to the loads.

a. SOLAR ENERGY SYSTEM:

Energy from the sun is the solar energy. The PV Panel is used to convert the solar energy into electrical energy. PV Panel is a group of PV cells connected in series or parallel. PV cell consists of two layers and a separation layer wired together to form a module. When the panel is exposed to sun light, the photons from the sun interact with the electrons present in the top layer of the solar cell which looses the atom. This atom moves towards the electrons in the bottom layer of the cell. This looses the atom and move towards the wire.

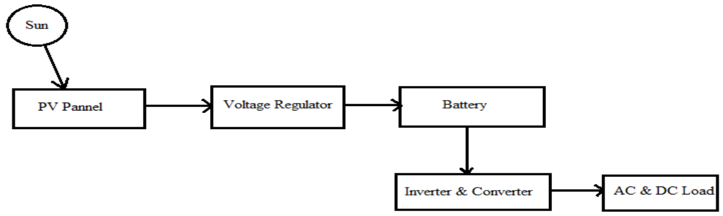

Fig.2. Block diagram of solar energy system

A solar cell is the most fundamental component of a photovoltaic (PV) system. The PV array is constructed by many series or parallel connected solar cells to obtain required current, voltage and high power. Each Solar cell is similar to a diode with a p-n junction formed by semiconductor material. When the junction absorbs light, it can produce currents by the photovoltaic effect. The output power characteristic curves for the PV array at an insolation are shown in Fig.It can be seen that a maximum power point exists on each output power characteristic curve. The Fig shows the (I-V) and (P-V) characteristics of the PV array at different solar intensities. The equivalent circuit of a solar cell is the current source in parallel with a diode of a forward bias. The output terminals of the circuit are connected to the load.

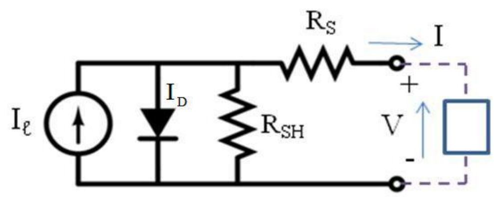

Fig 3. Equivalent circuit of PV Module

Where: Iph = Photo current (A)

Id = Diode current (A)

Ish = Shunt current (A)

VD = Voltage across diode (Volt)

I0 = Diode reverse saturation current (A)

q = Electron charge = 1.6X10-19 (C)

k = Boltzmann constant = 1.38X10-23 (J/K)

T = Cell temperature (K)

Rs = series resistance (Ω)

Rsh = shunt resistance (Ω)

The power output of a solar cell is given by $P_{pv} = V * I$

Where: I = solar cell output current (A)

V = Operating voltage of solar cell (volt)

P_{pv} =Output power of solar cell (W)

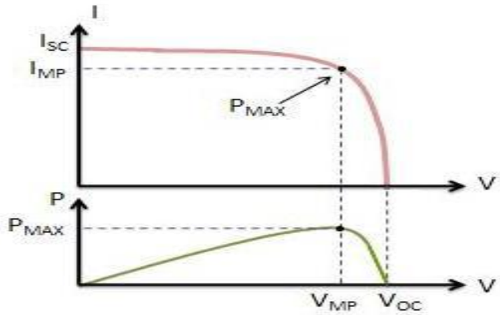

Fig.4. Output characteristics of PV Array

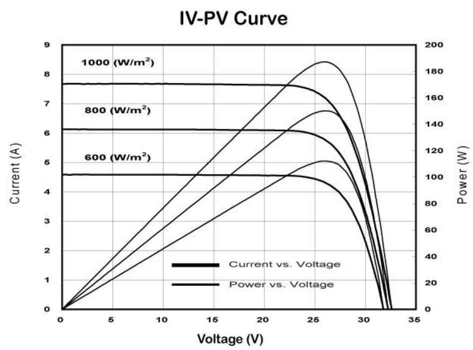

Fig.5. I-V and P-V Characteristics of PV Array

b. Wind Energy System

Wind results from the air in motion. Wind causes by the uneven heating of the land and the water. The aero turbine is used to converter the wind energy into mechanical energy. The turbines are of horizontal and vertical axis turbine. The pitch control and yaw control is used in the aero turbine.

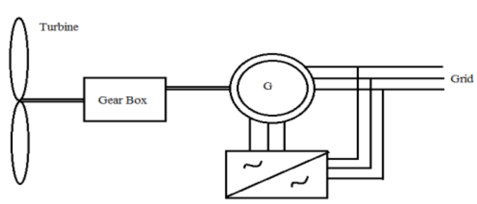

Fig.6.design of wind turbine

The gear box is used to increases the speed which prevent the turbine. Generators are used to convert the mechanical energy into the electric energy. Synchronous and induction generators are used. Double fed induction generator is most Widely used generator in the wind power. Converters are used to control the rotor current. The output is given to the load. The wind turbine captures the wind's kinetic energy in a rotor consisting of two or more blades mechanically coupled to an electrical generator. The equation describes the mechanical power captured from wind by a wind turbine can be formulated as: Pm = 0.5ρACpV^3

Where

ρ= Air density (Kg/m3)

A = Swept area (m2)

Cp= Power coefficient of the wind turbine

Ʊ = Wind speed (m/s)

t = Time (sec)

The theoretical maximum value of the power coefficient Cp is 0.59. It is dependent on two variables, the tip speed ratio (TSR) and the pitch angle. The pitch angle refers to the angle in which the turbine blades are aligned with respect to its longitudinal axis. *TSR* is defined as the linear speed of the rotor to the wind speed.

c. Fuel Cell

A fuel cell is a device that converts the chemical energy from a fuel into electricity through a chemical reaction with oxygen or another oxidizing agent. Hydrogen produced from the steam methane reforming of natural gas is the most common fuel, but for greater efficiency hydrocarbons can be used directly such as natural gas and alcohols like methanol. Fuel cells are different from batteries in that they require a continuous source of fuel and oxygen/air to sustain the chemical reaction whereas in a battery the chemicals present in the battery react with each other to generate an electromotive force (emf). Fuel cells can produce electricity continuously for as long as these inputs are supplied

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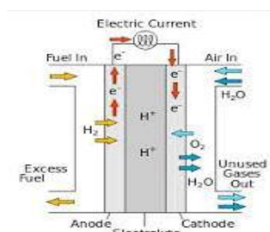

Fig.7.schematic diagram of fuel cell

In addition to electricity, fuel cells produce water, heat and, depending on the fuel source, very small amounts of nitrogen dioxide and other emissions. The energy efficiency of a fuel cell is generally between 40–60%, or up to 85% efficient in cogeneration if waste heat is captured for use.

III.BOOST CONVERTER

The high step-up conversion may require two-stage converters with cascade structure for enough step-up gain, which decreases the efficiency and increases the value of cost. Therefore, a high step-up converter is seen as an important stage in the system because such a system requires a sufficiently high step-up conversion with high efficiency. Thus, in recent years, many novel high step-up converters have been developed. Despite these advances, high step-up single-switch converters are unsuitable to operate at heavy load given a large input current ripple, which increases transmission losses. The conventional boost converter is an excellent candidate for high-power applications and power factor correction.

A boost converter (step-up converter) is a DC-to-DC power converter with an output voltage greater than its input voltage. It is a class of switched-mode power supply (SMPS) containing at least two semiconductors (a diode and a transistor) and at least one energy storage element, a capacitor, inductor, or the two in combination. Filters made of capacitors (sometimes in combination with inductors) are normally added to the output of the converter to reduce output voltage ripple.

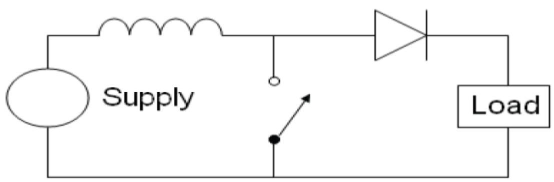

Fig.8.schematic diagram of boost converter

Power for the boost converter can come from any suitable DC sources, such as batteries, solar panels, rectifiers and DC generators. A process that changes one DC voltage to a different DC voltage is called DC to DC conversion. A boost converter is a DC to DC converter with an output voltage greater than the source voltage. A boost converter is sometimes called a step-up converter since it "steps up" the source voltage. Since power must be conserved, the output current is lower than the source current.

IV.SIMULATION RESULTS

The proposed system is designed using the simulink model and their results are obtained. Solar panel and the fuel cells are also designed and then given to the boost converters.

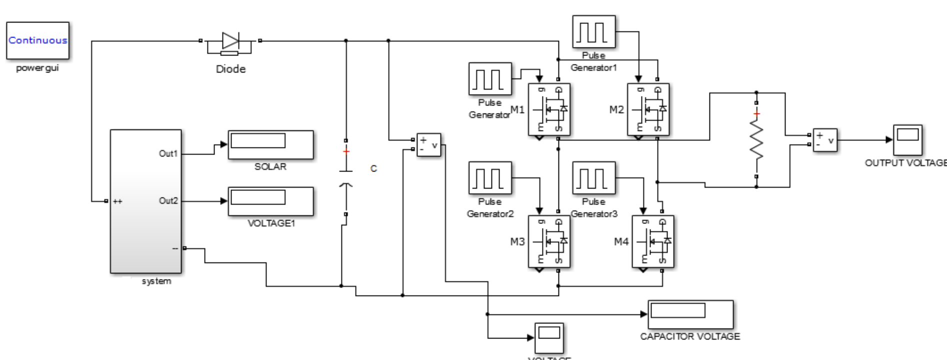

Fig.9. simulink diagram of proposed system

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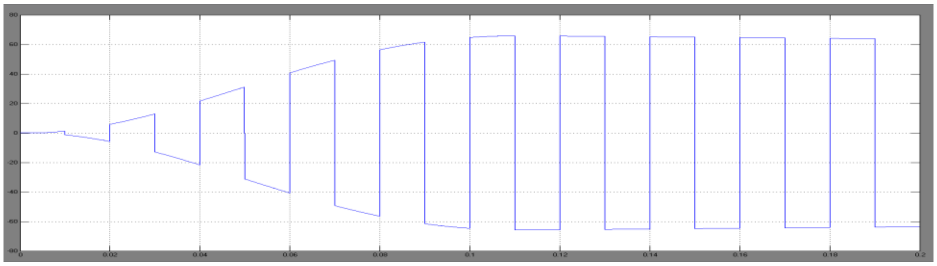

Fig.10. Output Voltage of The Proposed System

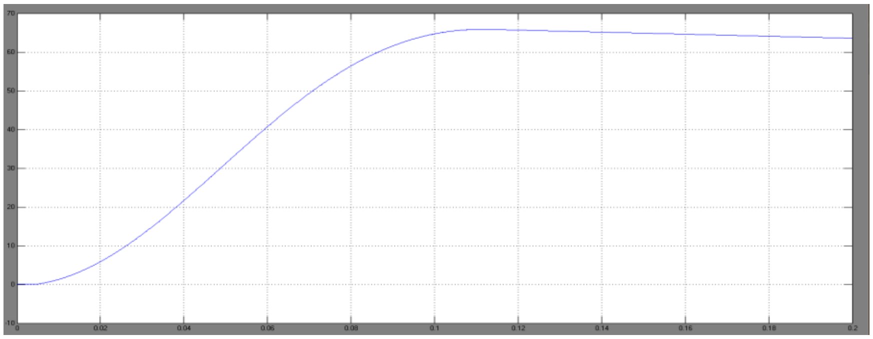

Fig.11. Dc Output Voltage of the Proposed System

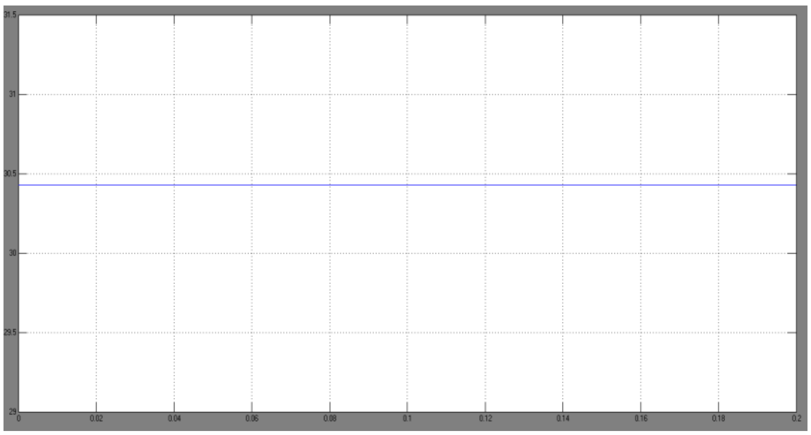

Fig.12. Output Voltage of the Fuel System

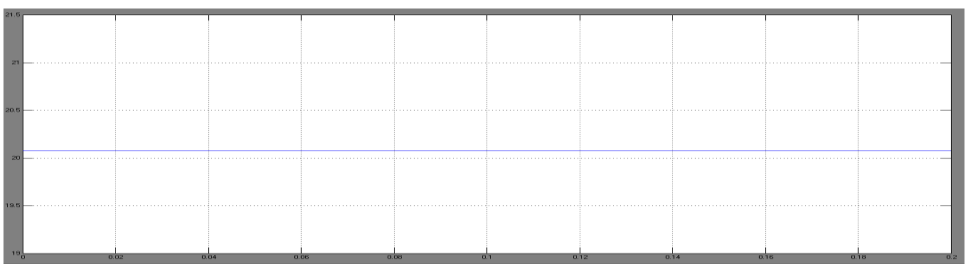

Fig.13. Output Voltage of the Solar System

V. CONCLUSION

The renewable energy system is presented for the high step-up high efficiency converter. In this proposed work the boost converter is used to reduce the current stress of switching devices. The output of the renewable energy is step up as the requirement of the load with higher efficiencies and good power factor. Boost converter along with the solar, fuel cell were simulated and the simulation results are verified.

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